PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 : B01D 50/00, 47/14, F24C 15/20

A1

(11) International Publication Number: WO 93/18348

(43) International Publication Date: 16 September 1993 (16.09.93)

(21) International Application Number: PCT/CA93/00089

(22) International Filing Date: 3 March 1993 (03.03.93)

(30) Priority data:
2,062,339 5 March 1992 (05.03.92) CA

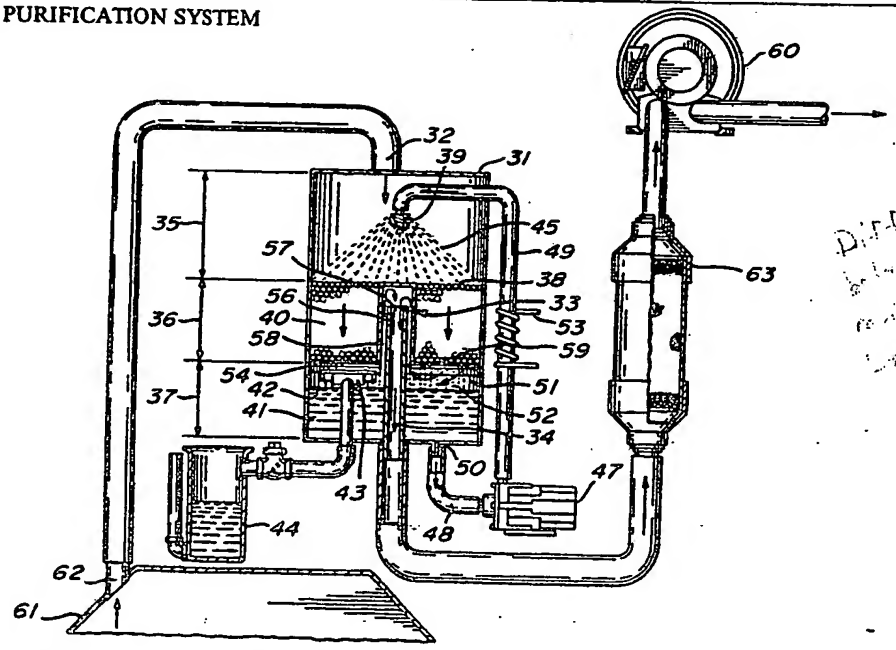
(71)(72) Applicant and Inventor: FAUTEUX, Lucien [CA/CA]; 24 Somerville Avenue, Montreal, Quebec H3Z 1J2 (CA).

(74) Agent: KOSIE, Ronald, S.; Brouillette Woods, 2000 McGill College, Suite 1100, Montreal, Quebec H3A 3H3 (CA).

(81) Designated States: AT, AU, BB, BG, BR, CH, CZ, DE, DK, ES, FI, GB, HU, JP, KP, KR, LK, LU, MG, MN, MW, NL, NO, NZ, PL, PT, RO, RU, SD, SE, SK, UA, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, SN, TD, TG).

Published
*With international search report.*
*Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.*

(54) Title: FUME PURIFICATION SYSTEM




(57) Abstract

The present invention relates to an exhaust fume gas purification system which may be used in conjunction with food cooking equipment. In accordance with the purification system, exhaust fume gas (which is generated during cooking) is passed through a container having three zones, namely an upper quench zone (35), an intermediate fixed bed zone (36) and a lower sump zone (37). The exhaust fume gas is first made to pass through the quench zone which is provided with quench spray means (39) for contacting the exhaust fume gas with a liquid medium. Thereafter, the fume gas passes through the fixed bed zone (40) which may comprise, for example, a plurality of filter elements in the form of glass marbles, the filter elements being wetted by liquid medium from the quench zone. The fume gas then passes from the fixed bed zone to the lower sump zone from which the scrubbed exhaust fume gas is discharged from the container.

*FOR THE PURPOSES OF INFORMATION ONLY*

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

| | | | | | |
|---|---|---|---|---|---|
| AT | Austria | FR | France | MR | Mauritania |
| AU | Australia | GA | Gabon | MW | Malawi |
| BB | Barbados | GB | United Kingdom | NL | Netherlands |
| BE | Belgium | GN | Guinea | NO | Norway |
| BF | Burkina Faso | GR | Greece | NZ | New Zealand |
| BG | Bulgaria | HU | Hungary | PL | Poland |
| BJ | Benin | IE | Ireland | PT | Portugal |
| BR | Brazil | IT | Italy | RO | Romania |
| CA | Canada | JP | Japan | RU | Russian Federation |
| CF | Central African Republic | KP | Democratic People's Republic of Korea | SD | Sudan |
| CG | Congo | | | SE | Sweden |
| CH | Switzerland | KR | Republic of Korea | SK | Slovak Republic |
| CI | Côte d'Ivoire | KZ | Kazakhstan | SN | Senegal |
| CM | Cameroon | LI | Liechtenstein | SU | Soviet Union |
| CS | Czechoslovakia | LK | Sri Lanka | TD | Chad |
| CZ | Czech Republic | LU | Luxembourg | TG | Togo |
| DE | Germany | MC | Monaco | UA | Ukraine |
| DK | Denmark | MG | Madagascar | US | United States of America |
| ES | Spain | ML | Mali | VN | Viet Nam |
| FI | Finland | MN | Mongolia | | |

# FUME PURIFICATION SYSTEM

The present invention relates to a fume gas purification system which may be used in conjunction with food cooking equipment. The system may, in particular, be used with cooking equipment wherein the cooking zone or area is completely enclosed in a housing or cooking hood such as, for example, a self-contained fried food (dispensing) machine.

## DESCRIPTION OF THE PRIOR ART

Typically food items such as french fries, onion rings, chicken nuggets, fish nuggets, and the like are prepared by being heated or cooked in a hot cooking liquid (such as an oil or fat). Since such food products have a high water content, the largest constituent of the exhaust fume gas is water vapour or steam. However, the fume gas is typically a complex blend or mixture of gases, vapours and/or particulates (the blend usually including air) which also contains a certain amount of particulate matter and/or gasified oil/fat residues. The organic component of the exhaust fume gas may, for example, include high temperature degradation products of the cooking oil and of any animal fats contained in the products themselves. It is therefore desirable to be able to remove fume gas from the cooking area in order to avoid an undesirable accumulation of organic matter such as grease etc. on the surfaces of various objects in the vicinity of the cooking area, the accumulation of which could present a danger (e.g. of fire).

Fume gas removal systems which use fans to transport fume gas from a (interior) cooking area to some more remote location are widely used in commercial and residential buildings. The simplest system expels fume gas (which includes air) from the cooking area of a

building into the atmosphere using a fan. In most instances, however, a fan is used in association with a canopy exhaust hood and a filter; under the influence of the fan, the exhaust hood channels fume gas (which includes air) from the cooking area to the filter which removes (condensed) particulates (of grease and the like) before the fume gas combination is subsequently expulsed. However, such filters get rapidly clogged up with grease material with the resulting loss of filtering efficiency.

Other more complex systems are also known. U.S. patent no. 4,900,341 to Csabai , for example, relates to a purification system for scrubbing exhaust fume gas generated during cooking. The system as taught in this patent generally comprises

a) a container comprising
   a (lower) inlet,
   an (upper) outlet, and
   a fixed packed bed (comprising a plurality of stationary filter elements) disposed between the inlet and the outlet,
b) cooling means;
c) wetting means to wet said filter elements;
d) means for collecting liquid, contaminant particles and condensates, etc.; and
e) a blower to induce a negative pressure in said outlet.

In accordance with the teachings of this reference, exhaust fume gas is passed through a chilled mass of wetted filter elements (e.g. glass balls or marbles) such that:

a) water vapour is condensed;
b) the wet surfaces of the filter elements captures solid particulate matter impinging thereon; and
c) vaporized organic material such as fat or oil

also

condenses out the fume gas.

However, it is to be particularly noted that U.S. patent no. 4,900,341 teaches or points to a system wherein:

a) the container has an inlet which is operatively connected to the lower portion of the container and an outlet which is operatively connected to the upper portion of the container;

b) the fixed packed bed is disposed above, and is spaced apart from, the inlet which is associated with the lower portion of the container,

d) the means for cooling the exhaust fume gas (e.g. to induce the condensation of a condensable component of the exhaust fume gas) includes a cooling coil which surrounds the outside surface of the container itself;

e) the wetting means includes means for recirculating a wetting liquid medium from the lower portion for redistribution over the filter elements; and

f) it is taught to direct about 2/3 of the recirculated liquid medium through the filter elements and 1/3 against the chilled, vertical inside wall of the container such that a uniform capillary coating on the filter elements may be attained for scrubbing while the portion of the liquid medium flowing down on the walls, is chilled so as to absorb heat from the (hot) exhaust fume gas.

The net result of the above is that for the system as taught in U.S. patent 4,900,341, the exhaust fume gas and the contaminant collecting liquid medium flow in counter current fashion relative to each other; additionally, heat is drawn from the system along the side walls of the

container while relatively hot fumes may pass up through the filter elements starting from below the filter elements. Therefore exhaust fume gas which percolates upwards through the center of the filter elements can contact liquid medium which is relatively warm as compared to the liquid medium adjacent the cooled side wall of the container or which is initially introduced at the top of the filter elements. This can encourage a relatively gradual cooling of the exhaust fume gas such that any condensable component(s) of the exhaust fume gas may have sufficient time to coalesce around the outer surface of the filter elements and form hard to remove films thereabout. This can lead to clogging and require that countermeasures be taken such as the introduction of a detergent or the like into the recirculation circuit to facilitate removal of such coatings. However, the addition of a detergent or the like can itself lead to undesirable side effects such as foaming which in turn must also be dealt with by additional measures such as the addition of antifoaming agents. The use of detergents etc. may thus increases the complexity of the cleaning liquid and require constant vigilance on the part of an operator such that these additives are not carried by recycled air back to the cooking area so as to contaminate the cooking area.

It would be advantageous to have a scrubber system of the type described in U.S. patent no 4,900,341 but which may avoid the above mentioned disadvantages.

It would also be advantageous to have an effective scrubber system which is efficient, economical, easily installed and has low operation and maintenance costs.

It would in particular be advantageous to have a fume purification system which could effectively be used in a fried food dispensing machine.

## SUMMARY OF THE INVENTION

Surprisingly, in accordance with the present invention, it has been observed that by first passing the exhaust fume gas through a quench zone followed by passage through a zone comprising a packed bed such as disclosed in U.S. patent 4,900,341, a condensate layer does not tend as readily to build up over the filter elements and that the spaces between the filter elements have less tendency to become obstructed. The separated fume contaminants may thereafter be removed from the following sump zone in any (known) manner such as described, for example, in U.S. patent 4,900,341 referred to above. The present invention thus exploits a three zone system, namely a system having an upper quench zone, an intermediate fixed bed zone and a lower sump zone (as shall be described herein).

In accordance with the present invention, the word "quench" is to be understood as being a characterization (relative to fume gas) indicative of a temperature drop and/or an entrainment of (solid) particles, as effected by liquid particles of a spray of liquid medium. Thus, for example, in accordance with the present invention any reference to expressions such as "quench zone", "quench effect" or the like are to be understood as being a reference to a zone, effect, etc., wherein the temperature of the fume gas may be lowered and/or (solid) particles thereof may be entrained (e.g. taken up, captured, entrapped, etc.) by liquid particles of a (quench) spray of liquid medium.

The present invention, in a general aspect, provides a purification system for scrubbing exhaust fume gas from a cooking area, said system having,

a container having gas inlet means for the intake of said exhaust fume gas and gas outlet means for the discharge of scrubbed exhaust fume gas therefrom,

said container having a flow path defined therein for communicating said inlet means with said outlet means, said flow path including a fixed bed zone and a lower sump zone, said fixed bed zone comprising a plurality of filter elements, said lower sump zone being disposed below said fixed bed zone,

wetting means for wetting said filter elements with a liquid medium,

said lower sump zone being configured to collect liquid medium leaving said fixed bed zone, said wetting means having a recirculation circuit comprising recycle means for recycling liquid medium from said sump zone to said filter elements for wetting said filter elements,

cooling means for cooling said liquid medium,

overflow means for draining liquid medium from said sump zone so as to limit the level of liquid medium in said lower sump zone, and

blower means for inducing negative pressure at said gas outlet means,

said system being characterized in that

said flow path includes

an upper quench zone for contacting said exhaust fume gas with said liquid medium prior to passage of exhaust fume gas through said fixed bed zone,

said gas inlet means is operatively connected to said upper quench zone,

said quench zone has quench spray means for providing a quench spray of said liquid medium for contacting exhaust fume gas delivered to said quench zone from said gas inlet means,

said recycle means comprises means for recycling liquid medium from said lower sump zone to said quench spray means,

said cooling means comprises means for cooling the liquid medium prior to delivery thereof to said quench spray means, and

said gas outlet means has outlet aperture means communicating with the lower sump zone, said outlet aperture means being disposed so as to be above the level of the liquid medium as defined by the overflow means.

As indicated above, in accordance with the present invention, it has been observed that it is advantageous to initiate the scrubbing of exhaust fume gas by first passing the exhaust fume gas through a quench zone. In the quench zone, the fume gas may be brought into contact and intermingle with a liquid medium spray (e.g. of finely divided liquid particles, a liquid mist or the like). By means of such contact, for example, any hot exhaust gas may be relatively rapidly (or suddenly) cooled. It is believed, that the condensation, in this way, of any condensable component of the fume gas, produces more or less (solid) contaminant particles of relatively small size as compared to the spacing between the filter elements and which have less tendency to coalesce and stick to the surface of the filter elements.

In accordance with the present invention, the temperature of the liquid medium used to quench the fume gas, the flow rate of the recycled liquid medium, the spray pattern produced by a quench spray head(s) (or nozzle(s)), the disposition of the exhaust fume gas inlet with respect to the quench spray pattern, etc., are selected, (in light of the temperature of the incoming exhaust fume gas, the flow rate of the incoming fume gas, the particle content of the incoming exhaust fume gas, etc.) with a view to bring the fume gas stream and the liquid medium into collision above the fixed bed zone, for the formation and/or capture of fume particles into drop(let)s of liquid medium, which after passing through the fixed bed, may be collected from

the sump zone.

As mentioned, the quench zone has quench spray means for providing a quench spray of the liquid medium for contacting exhaust fume gas which is delivered to the quench zone from the gas inlet means. The quench spray means may take any form whatsoever for this purpose. The spray means may, for example, comprise one or more quench spray heads or nozzles for developing a quench spray. The quench spray produced by the quench spray means may take on any spray pattern configuration and may be oriented in any direction or fashion in the quench zone provided that the spray produced is such that fume gas and liquid medium (particles) come into collision above the fixed bed zone, i.e. the desired "quench effect" is obtained thereby. If more than one spray head is involved all of the spray heads may each produce a spray oriented in a common direction; they may each produce a spray oriented in a different direction; or groups of spray heads may provide a spray orientation different from other group(s) of spray heads; etc...

The quench spray means may, for example, provide a spray pattern of conical configuration; a conical configuration may comprise one or more conical elements (provided by one or more spray heads) which may each, if desired, be directed towards the fixed bed zone. The quench spray means may, for example, comprise a quench spray head which develops a conical spray pattern directed towards the fixed bed zone. It is to be understood that a reference to a spray pattern, as being directed towards the fixed bed zone, is a reference to a spray pattern wherein liquid medium is initially sprayed in the (general) direction of the fixed bed zone rather than, for example, (generally) sideways towards the container wall or (generally) upwards away from the fixed bed (although these latter orientations may also be possible).

In accordance with the present invention the cooling means may take any desired configuration. The cooling means, for example, may, if desired, comprise a refrigeration member (e.g. cooling coil) which surrounds (at least the outside surface of the walls of) the container adjacent the lower sump zone (the container/coil combination may have a configuration analogous to that described in the U.S. patent 4,900,342 mentioned above); in this case the liquid medium is chilled in the lower sump zone prior to entering the recirculation circuit.

However, in accordance with a preferred aspect of the present invention, the recirculation circuit itself may include cooling means for cooling the liquid medium prior to delivery thereof to the quenching spray means. Thus, in accordance with the present invention, the recirculation circuit may, for example, have cooling means comprising a tubing member for the conveyance of liquid medium through the interior thereof and a refrigeration member disposed for the extraction of heat from liquid medium passing through the tubing member, the refrigeration member being operatively connected to a refrigerator system for the extraction of heat from liquid medium passing through said tubing member.

The tubing member and the refrigeration member may, for example, form an integral unit wherein the refrigeration member forms part of the tubular wall of the tube member; the refrigeration member may, for example, have the configuration of a coil member having an inlet and outlet for a cooling medium used to extract heat from the liquid medium. Alternatively, the tubing member and the refrigeration member may be separate elements; in this case, the refrigeration member may be a refrigeration (e.g. coil) member which may, if desired, be disposed within the tube member (so as to be directly in the path of the liquid medium) or it may be disposed about the

exterior of the tubing member. If the refrigeration (e.g. coil) member is disposed within the tubing member, any inlet and outlet means thereof will of course have to pass through the wall of the tubing member for connection to a refrigeration system; if the refrigeration (e.g. coil) member is disposed about the exterior of the tubing member it will be in heat transfer contact with the tubing member in some suitable fashion (e.g. simple contact, welded contact, etc.).

It has been observed that, by placing cooling means in the recirculation circuit, a lower liquid medium temperature (during continuous use) may be more readily obtained and maintained, than as was observed for a system such as shown in U.S. patent no. 4,900,341. Accordingly, this preferred configuration may provide for a relatively low temperature liquid medium for delivery to the quench zone, the temperature of the liquid medium being relatively more readily controllable by extracting heat from the liquid medium as it passes through the recirculation circuit. The refrigeration system, which may be connected to the refrigeration member, may be manipulated as desired in any (known) manner. By way of example, the temperature of the liquid medium in the lower sump zone may, if desired, be maintained in the temperature range of from about 5º to about 10º C.

The refrigeration system may take any (known) form provided that it effects the desired heat extraction. The refrigeration system may, for example, comprise a cooling system wherein cooling liquid (e.g. relatively cool water) is circulated through the refrigeration member. Alternatively, the refrigeration member may be connected to or form part of a (known) compressor/evaporator/condenser refrigeration system or arrangement.

In accordance with the present invention, the gas outlet means may include (cover) means for inhibiting liquid medium from falling or passing into the outlet means. More particularly, the gas outlet means may have a head portion configured to so inhibit the liquid medium; the end of the gas outlet means may, for example, be U-shaped and be disposed upside down so that the end of one arm of the U defines the gas outlet aperture which communicates with the lower sump zone and the other arm of the U communicates with the rest of the outlet means.

Alternatively, the outlet means may comprise a head portion and a main portion, the head portion defining a channel for changing the direction of flow of the scrubbed fume gas upwards before the scrubbed fume gas is discharged, the channel having an upper end and a lower end, the upper end communicating with a discharge channel defined by the main portion, and the lower end comprising the outlet aperture means.

The head portion may, for example, comprise an outer tubular member open at one end and closed off at the other end; the main portion may also comprise a tube member; an end element of the tube member (hereinafter referred to as the inner tube element) may be sized so as be disposed within the outer tubular member such that a portion thereof extends out of the open end of the outer tubular member and the open end of the inner tube element within the outer tubular member is adjacent to but spaced apart from the closed end of the outer tubular member. The outer tubular member and the inner tube member can be spaced apart such that they define an annular channel therebetween; the open end of the inner tube member which is adjacent the closed end of the outer tubular member may communicate with the upper end of the annular channel. The lower end of the annular channel can in this way define an annular aperture communicating with the lower

sump zone. The inner element may be spaced apart from the outer tubular member in any suitable fashion such as by spacer elements, etc..

The filter elements may take any suitable (known) form; e.g. spherical (glass) balls such as glass marbles. Other types of filter elements may include known packing elements such as raschig rings, berl saddles, etc.

In accordance with the present invention, the blower means may be operatively connected to the gas outlet means by a charcoal filter cartridge and the blower means may communicate with the atmosphere for the discharge of scrubbed fume gas to the atmosphere.

The purification system of the present invention may particularly be used in conjunction with a self-contained fried food dispensing machine wherein fume gas generated during cooking of food products in a hot cooking oil bath are collected (from a hood enclosing the cooking area), cooled and purified with the scrubbed fume gas being vented to the atmosphere instead of being recirculated to the hood; in this way a negative pressure may be maintained in the hood.

## DESCRIPTION OF THE DRAWINGS

An example embodiment of the invention is illustrated in the drawings wherein:

Figure 1 is a schematic side view of the prior art system taught in U.S. patent no. 4,900,341 partially cut away to expose interior features thereof;

Figure 2 is a schematic side view of an example embodiment of a system in accordance with the

present invention partially cut away to expose interior features thereof;

Figure 3 is a top view of the spray pattern produced by the quench spray head shown in figure 2, and

Figure 4 is a partially cut away detail perspective view of the outlet means shown in figure 2.

The prior art system of U.S. patent 4,900341 ( as illustrated in figure 1) and the example system of the present invention (as illustrated in figure 2) will both be described hereinafter in order to illustrate the differences between the present invention and the teachings of the U.S. patent. Both systems will be described in relation to exhaust fume gas produced during the frying of a food product in a hot cooking oil or fat; the exhaust fume gas being confined in a hood which is mounted right over and fully encloses the frying area (not shown). An exhaust port is located on one side of the hood where the fume gas is concentrated. Exhaust fume gas is sucked from the exhaust port into a condenser unit where most of the fume gas purification and conditioning takes place.

Referring to figure 1, the prior art system shown, has a container which is configured as a cylindrical double walled container; the outer wall 1 is spaced apart from the inner wall 2. The inner wall 2 defines the interior boundaries of the container. A (copper) tube (refrigeration) cooling coil 3 is disposed between the outer wall 1 and the inner wall 2; the coil 3 extends from the bottom of the inner wall to a point adjacent the top thereof. The coil 3 is helically wound around the cylindrical inner wall 2 and is in heat transfer contact with the outer surface of the inner wall 2 (e.g. the wall 2 and coil 3 are made of heat conducting material and the

coil 3 may be welded to the surface of the wall 2). To provide cooling, the coil 3 may be part of a refrigeration system (not shown) which can comprise a suitable (known) compressor/evaporator/condenser refrigeration arrangement; the coil 3 being configured to extract heat from the interior of the container through the wall 2.

The container has an upper gas outlet 4 which communicates with the interior of the container through a removable double walled access cover 5; the portion of the inlet 4 defining the inlet aperture thus communicates with the upper portion of the interior of container. The container also has a lower inlet the aperture of which is designated by the reference number 6; as may be seen the inlet extends through the double wall of the base of the container sufficiently such that the inlet aperture 6 is above the level 7 of the liquid medium 8 (e.g. an aqueous medium such as water or a water solution) in the lower portion of the container.

The container has an upper portion as indicated by the reference number 9 and a lower portion as indicated by the reference number 10. The upper portion 9 corresponds to a fixed bed zone whereas the lower portion 10 corresponds to a lower sump zone; these zones are both in the flow path whereby the inlet 4 is in fluid (i.e. gas) communication with the outlet 6.

The fixed bed zone comprises a bed 11 of filter elements which consist of solid glass balls (e.g. marbles). The bed 11 extends laterally completely across the interior of the container. The balls are packed and supported on a circular wire mesh 12. The mesh 12 is fixed relative to the inner surface of the wall 2 by being supported on brackets which are fixed (e.g. welded) to the wall 2. The mesh 12 has openings large enough to allow liquid medium, gas , etc. to pass through but still support the

bed 11 thereabove. The bed 11 extends upwardly to a point adjacent the cover 5; as seen, a layer 13 of the balls at the top of bed 11 covers a spray head 14 which shall be referred to again below. The lower sump zone contains the liquid medium 8, the level 7 of which is determined by the "T" shaped overflow 15. The overflow 15 has a wide mouth; the opening of the mouth is flush with the level of liquid medium 8 which it is desired to be maintained in the lower sump zone. The overflow 15 is necessary because the water content of the liquid medium is continuously augmented by condensation water from the exhaust fume gas. The overflow also allows for drainage of any (layer of) fat/oil scrubbed from the fume gas. Excess liquid medium is drained off into the tank 16 via piping and a check valve 17; the check valve 17 is present to prevent air from entering the lower sump zone through the overflow 15 since during operation the container is under negative pressure.

The liquid medium 8 in the sump zone can be recirculated continuously by a recirculation circuit which comprises recycle means comprising a pump 18 and two conduits members 19 and 20. The conduit member 19 has an inlet 21 at the base of the lower sump zone; from inlet 21 liquid medium can pass through the pump 18 to conduit 20. Conduit 20 can convey the liquid medium to the spray head 14 from which the liquid medium may be distributed over the filter elements (i.e. balls) so as to cascade downwardly through the filter elements wetting them and eventually leaving the fixed bed zone and falling back into the lower sump zone as indicated generally by the reference number 22.

Plate 23 and cap 24 are respectively disposed over the inlet aperture 6 and the opening of the overflow 15 to prevent drops of the cascading liquid medium from entering into the aperture 6 and the overflow opening. The

circular plate 23 is mounted on the mesh 12 such that it also deflects the incoming gas stream form inlet aperture 6 laterally for distribution at the bottom of the marble packing.

A blower 25 is operatively connected to the outlet 4 to induce a negative pressure at the inlet aperture 6 while sucking treated fume gas out of outlet 4. When the blower 25 and the pump 18 are activated, the exhaust fume gas entering the container by inlet aperture 6 percolates upwardly through the bed 11 in the direction of the arrow 26 as liquid medium flows downwardly in the opposite direction for return to the lower sump zone.

To complete the purification the blower 25 pushes the treated fume gas through a charcoal filter cartridge 28 before being returned to the hood 29 at inlet port 30. The charcoal cartridge 28 is intended to remove any remaining odour and gas constituents before the scrubbed fume gas is directed into the hood 29; reference may be made to U.S. patent 4,900,341 for a more detailed description of such cartridges. Known cartridges such as those made by AMETEK, Wisconsin, U.S.A. may be used for this purpose.

Referring now to figure 2, the illustrated system (which is an example embodiment of a purification system in accordance with the present invention) has a container which is configured as a cylindrical single wall container 31.

The container 31 has an upper gas inlet 32 which communicates with the upper portion of the interior of container 31; the top of the container to which the inlet 32 is attached may comprise a removable top to provide access to the interior of the container 31. The container 31 also has a lower outlet which has a head portion 33 and

a main portion 34.

The container 31 has an upper portion as indicated by the reference number 35, an intermediate portion designated by the reference number 36 and a lower portion as indicated by the reference number 37. The upper portion 35 corresponds to a quench zone, the intermediate portion 36 corresponds to a fixed bed zone and the lower portion 37 corresponds to a lower sump zone; these three zones are all in the flow path whereby the inlet 32 is in fluid (i.e. gas) communication with the outlet.

The fixed bed zone of the system illustrated in figure 2 is essentially the same as the fixed bed zone illustrated and described above with respect to figure 1. Accordingly, only those features of the fixed bed zone of figure 2 which are different from the fixed bed zone shown in figure 1 will be referred to hereinafter. Thus, as can be seen from figure 2, the top 38 of the fixed bed zone is spaced apart from the quench spray head 39. Additionally the head portion 33 of the outlet extends up through the body of the (marble) bed 40.

The lower sump zone of the system shown in figure 2 is the same as the lower sump zone illustrated and described with respect to figure 1. Accordingly the lower sump zone of figure 2 will not be described in detail hereinafter. Thus, the lower sump zone of figure 2 is shown as containing a liquid medium 41, the level 42 of which is determined by the "T" shaped overflow 43. The overflow 43 drains liquid medium to a tank 44 in the same manner as previously described with respect to figure 1.

The quench zone has the quench spray head 39 disposed therein. The spray head 39 is shown as producing a spray of liquid medium which is directed towards the fixed bed zone. The quench spray extends laterally more or less

completely across the top 38 of the fixed bed zone. In this embodiment therefore the fume gas passing into the quench zone from the inlet 32 may face a spray pattern as shown in figure 3 if a spray head of the type HHSJ (from Spraying Systems Co. Pensylvania, U.S.A.) is used. The spray pattern (designated by the reference number 45) is shown in figure 2 as having an essentially conical form when viewed from the side but when viewed from the top as in figure 3 the spray also has a spiral like pattern (designated by the reference number 46); i.e. the three dimensional spray pattern is of a spiralling cone the apex of which is at the quench spray head 39. A different quench spray head may of course be used to produce other types of spray patterns and need not necessarily produce a spray covering the entire top 38 of the fixed bed zone provided of course that the desired "quench effect" is obtained.

The liquid medium in the sump zone of the system shown in figure 2 can be recirculated continuously by a recirculation circuit which comprises a pump 47 and two conduits members 48 and 49. The conduit member 47 has an inlet 50 at the base of the lower sump zone; from inlet 50, liquid medium can pass through the conduit 48 and the pump 47 to conduit 49. Conduit member 49 can convey the liquid medium to the quench spray head 31 from which the liquid medium may be sprayed to be brought into contact with the exhaust fume gas before both pass on through the fixed bed zone. After passing through the fixed bed zone the fume gas (as well as liquid medium) proceed to the lower sump zone. Passage of fume gas and liquid medium through the three zones generally proceeds in the result in occurrent-like fashion. The liquid medium distributed over the filter elements thus cascades downwardly through the filter elements (e.g. marbles) wetting them and eventually leaving the fixed bed zone and falling back into the lower sump zone as indicated generally by the

reference number 51. The fume gas in the lower sump zone as designated by the reference number 52 proceeds to the head portion 33 of the outlet for discharge as shall be explained hereinafter.

A portion of the conduit 49 thereof has a heat conducting cooling coil tube member 53 disposed thereabout in heat transfer contact. The coil 53 is helically wound around the portion of the conduit member 49. To provide cooling, the coil 53 may be part of a refrigeration system (not shown) which can have a known compressor/evaporator/condenser refrigeration arrangement; the coil 53 being configured to extract heat from the liquid medium passing through the portion of the conduit member 49 in heat transfer contact with the coil 53. This portion of the conduit member may for example comprise a coil section such as a Doucette coaxial coil available from Doucette Industries Inc., Pennsylvania USA.

The system may be associated with any suitable (known) control means for measuring temperature and flow rates, etc.

A cap 54 is disposed over the opening of the overflow 43 to prevent drops of the cascading liquid medium from entering into the overflow opening.

As mentioned above, the head portion 33 of the outlet extends up through the body of the (marble) bed 40. Referring to figures 2 and 4, the head portion 33 comprises an outer tubular member 55 open at one end and closed off at the other end. The main portion 34 comprise a tube end member 56. The end member 56 is disposed within the outer tubular member 55 such that a portion thereof extends out of the open end of the outer tubular member 55. The opening 57 of the tube end member 56 is adjacent to but spaced apart from the closed end of the

outer tubular member 55. The outer tubular member 55 and the tube end member 56 are spaced apart such that they define an annular channel 58 therebetween. The opening 57 the tube end member 56 communicates with the upper end of the annular channel. The lower end of the annular channel 58 defines an annular aperture 59 which communicates with the lower sump zone. As may be seen the annular aperture 59 communicates with the lower sump zone and is disposed such that it is above the level 42 of the liquid medium 41 (e.g. an aqueous medium such as water or a water solution) in the lower portion of the container. The end tube member 56 may be spaced apart from and fixed to the outer tubular member 55 in any suitable fashion such as by spacer elements, etc.(not shown). However, the outer tubular member 56, relative to the end tube member 57, may simply be fixed to and supported by the mesh supporting the (marble) bed 40 so that the end tube member 57 merely extends into the interior of the outer tubular member 56 without direct contact therewith; in this latter case, the mesh can be fixed (e.g. welded) to the outer surface of the outer tubular member 55 adjacent to the annular aperture 59.

A blower 60 is operatively connected to the outlet main portion 33 so as to be able when active to induce a negative pressure at the inlet aperture 32 while sucking treated fume gas out of outlet. When the blower 60, the pump 47 and the refrigeration system attached to the coil 53 are activated the system may proceed as follows: liquid medium passes upwardly through the conduit 49 where it is chilled by the coil 53 before being passed on to the quench spray head 39; exhaust gas from the hood 61 is sucked into the inlet 62 on the hood 61 where it is then passed on to the inlet 32 for injection into the quench zone for contact with the liquid medium spray from the quench spray head 31; the fume gas and liquid medium then proceed through the fixed bed zone and into the lower sump

zone where they separate; the separated liquid medium is then recirculated from the lower sump zone; the separated fume gas then passes through a charcoal filter cartridge 63 (such as described above with respect to figure 1) and is thereafter discharged from the blower 60 to the atmosphere.

The cooling means could, if desired, of course be disposed as part of conduit 48.

While a particular and preferred embodiment of the invention has been described, it is to be understood that various changes of materials and arrangements of the various may be made by those skilled in the art without departing from the spirit and scope of the present invention.

I CLAIM:

1. A purification system for scrubbing exhaust fume gas from a cooking area, said system having,

a container having gas inlet means for the intake of said exhaust fume gas and gas outlet means for the discharge of scrubbed exhaust fume gas therefrom,

said container having a flow path defined therein for communicating said inlet means with said outlet means, said flow path including a fixed bed zone and a lower sump zone, said fixed bed zone comprising a plurality of filter elements, said lower sump zone being disposed below said fixed bed zone,

wetting means for wetting said filter elements with a liquid medium,

said lower sump zone being configured to collect liquid medium leaving said fixed bed zone, said wetting means having a recirculation circuit comprising recycle means for recycling liquid medium from said sump zone to said filter elements for wetting said filter elements,

cooling means for cooling said liquid medium,

overflow means for draining liquid medium from said sump zone so as to limit the level of liquid medium in said lower sump zone, and

blower means for inducing negative pressure at said gas outlet means,

said system being characterized in that

said flow path includes

an upper quench zone for contacting said exhaust fume gas with said liquid medium prior to passage of exhaust fume gas through said fixed bed zone,

said gas inlet means is operatively connected to said upper quench zone,

said quench zone has quench spray means for providing a quench spray of said liquid medium for contacting exhaust fume gas delivered to said quench zone from said gas inlet means,

said recycle means comprises means for recycling liquid medium from said lower sump zone to said quench spray means,

said cooling means comprises means for cooling the liquid medium prior to delivery thereof to said quench spray means, and

said gas outlet means has outlet aperture means communicating with the sump zone, said outlet aperture means being disposed so as to be above the level of the liquid medium as defined by the overflow means.

2. A purification system as defined in claim 1 wherein the quench spray means provides a spray pattern of conical configuration.

3. A purification system as defined in claim 1 further comprising a hood disposed over said cooking area to confine said fumes therein and

wherein said gas inlet means is connected to the said hood and said gas outlet means communicates with the atmosphere for the discharge of scrubbed fume gas to the atmosphere.

4. A purification system as defined in claim 1 wherein the filter elements are spherical glass balls.

5. A purification system according to claim 1 wherein the cooling means includes a refrigeration member which is in heat transfer contact with said container adjacent the sump zone.

6. A purification system as defined in claim 1 said gas outlet means includes means for inhibiting liquid medium from passing into said outlet means.

7. A purification system as defined in claim 1 wherein the overflow means communicates with a reservoir for holding the liquid medium drained from said sump zone.

8. A purification system as defined in claim 1 wherein the overflow means comprises a "T" shape inlet, said inlet communicating with a reservoir for holding the liquid medium drained from said sump zone.

9. A purification system as defined in claim 1 wherein the blower means is operatively connected to the gas outlet means by a charcoal filter cartridge and the blower means communicates with the atmosphere for the discharge of scrubbed fume gas to the atmosphere.

10. A purification system for scrubbing exhaust fume gas from a cooking area, said system having,

a container having gas inlet means for the intake of said exhaust fume gas and gas outlet means for the discharge of scrubbed exhaust fume gas therefrom,

said container having a flow path defined therein for communicating said inlet means with said outlet means, said flow path including a fixed bed zone and a lower sump zone, said fixed bed zone comprising a plurality of filter elements, said lower sump zone being disposed below said fixed bed zone,

wetting means for wetting said filter elements with a liquid medium,

said lower sump zone being configured to collect liquid medium leaving said fixed bed zone, said wetting means having a recirculation circuit comprising recycle means for recycling liquid medium from said sump zone to said filter elements for wetting said filter elements,

cooling means for cooling said liquid medium,

overflow means for draining liquid medium from said sump zone so as to limit the level of liquid medium in said lower sump zone, and

blower means for inducing negative pressure at said gas outlet means,

said system being characterized in that

said flow path includes

an upper quench zone for contacting said exhaust fume gas with said liquid medium prior to passage of exhaust fume gas through said fixed bed zone,

said gas inlet means is operatively connected to said upper quench zone,

said quench zone has a quench spray means for providing a quench spray of said liquid medium for contacting exhaust fume gas delivered to said quench zone from said gas inlet means,

said recycle means comprises means for recycling liquid medium from said lower sump zone to said quench spray means,

said recirculation circuit includes cooling means for cooling the liquid medium prior to delivery thereof to said quench spray means, and

said gas outlet means has outlet aperture means communicating with the sump zone, said outlet aperture means being disposed so as to be above the level of the liquid medium as defined by the overflow means.

11. A purification system as defined in claim 10 wherein the quench spray means provides a spray pattern of conical configuration.

12. A purification system as defined in claim 10 wherein said recirculation circuit has cooling means comprising a tubing member for the conveyance of liquid medium through the interior thereof and a refrigeration member disposed for the extraction of heat from liquid medium passing

through said tubing member, said refrigeration member being operatively connected to a refrigerator system for the extraction of said heat.

13. A purification system as defined in claim 10 wherein said recirculation circuit has cooling means comprising a tubing member for the conveyance of liquid medium through the interior thereof and a refrigeration member disposed about the exterior of the tubing member, said refrigeration member being in heat transfer contact with the tubing member, said refrigeration member being operatively connected to a refrigerator system for the extraction of heat from liquid medium passing through said tubing member.

14. A purification system as defined in claim 13 wherein the quench spray means comprises a quench spray head, said quench spray head providing a conical spray pattern, the conical spray pattern being directed towards the fixed bed zone.

15. A purification system as defined in claim 14 further comprising a hood disposed over said cooking area to confine said fumes therein and
wherein said gas inlet means is connected to the said hood and said gas outlet means communicates with the atmosphere for the discharge of scrubbed fume gas to the atmosphere.

16. A purification system as defined in claim 15 wherein the filter elements are spherical glass balls.

17. A purification system as defined in claim 10 wherein said gas outlet means includes means for inhibiting liquid medium from passing into said outlet means.

18. A purification system as defined in claim 10 wherein the overflow means communicates with a reservoir for

holding the liquid medium drained from said sump zone.

19. A purification system as defined in claim 10 wherein the overflow means comprises a "T" shape inlet, said inlet communicating with a reservoir for holding the liquid medium drained from said sump zone.

20. A purification system as defined in claim 10 wherein the blower means is operatively connected to the gas outlet means by a charcoal filter cartridge and the blower means communicates with the atmosphere for the discharge of scrubbed fume gas to the atmosphere.

21. A purification system as defined in claim 1 wherein the outlet means comprises a head portion and a main portion, said head portion defining a channel for changing the direction of flow of the scrubbed fume gas upwards, before the scrubbed fume gas is discharged, said channel having an upper end and a lower end, said upper end communicating with a discharge channel defined by said main portion, and said lower end comprising said outlet aperture means.

22. A purification system as defined in claim 10 wherein the outlet means comprises a head portion and a main portion, said head portion defining a channel for changing the direction of flow of the scrubbed fume gas upwards before the scrubbed fume gas is discharged, said channel having an upper end and a lower end, said upper end communicating with a discharge channel defined by said main portion, and said lower end comprising said outlet aperture means.

23. A purification system as defined in claim 16 wherein the outlet means comprises a head portion and a main portion, said head portion defining a channel for changing the direction of flow of the scrubbed fume gas upwards

before the scrubbed fume gas is discharged, said channel having an upper end and a lower end, said upper end communicating with a discharge channel defined by said main portion, and said lower end comprising said outlet aperture means.

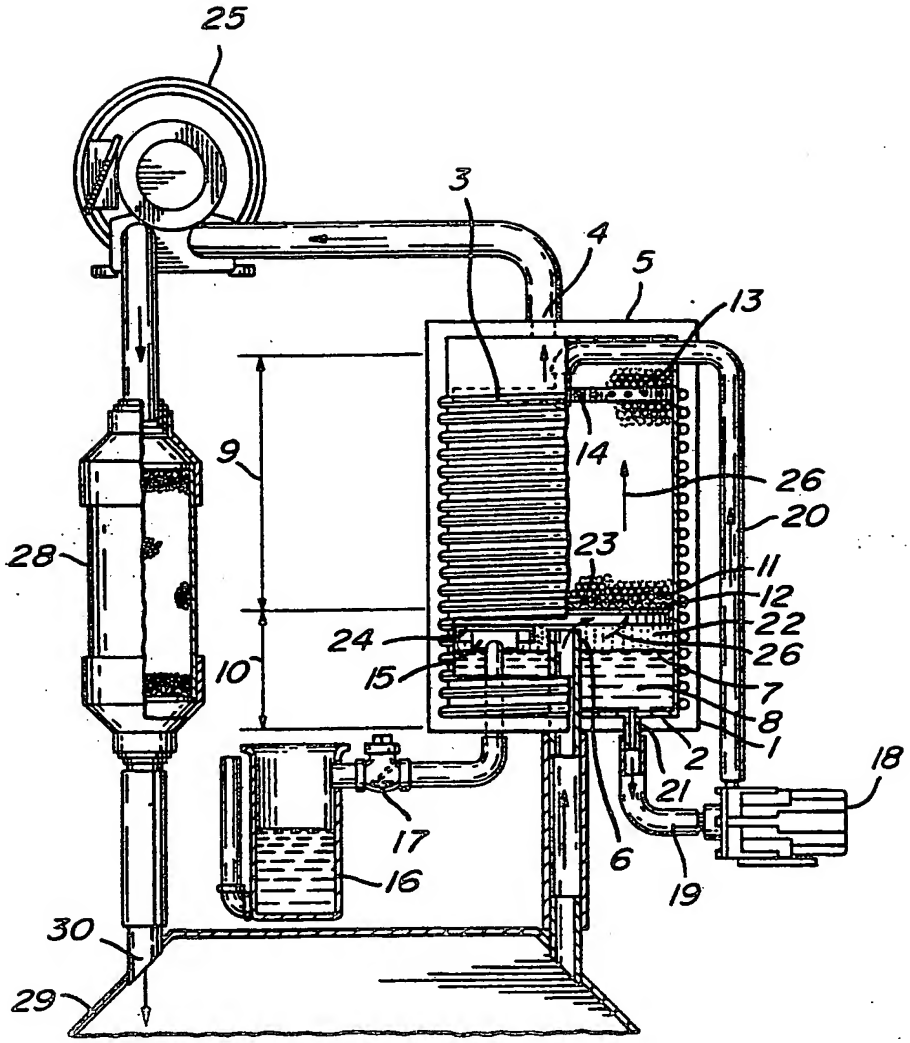

25
3
4
5
13
14
9
26
20
28
23
11
12
22
24
26
10
15
7
8
1
2
18
21
17
6
16
19
30
29

FIG. 1

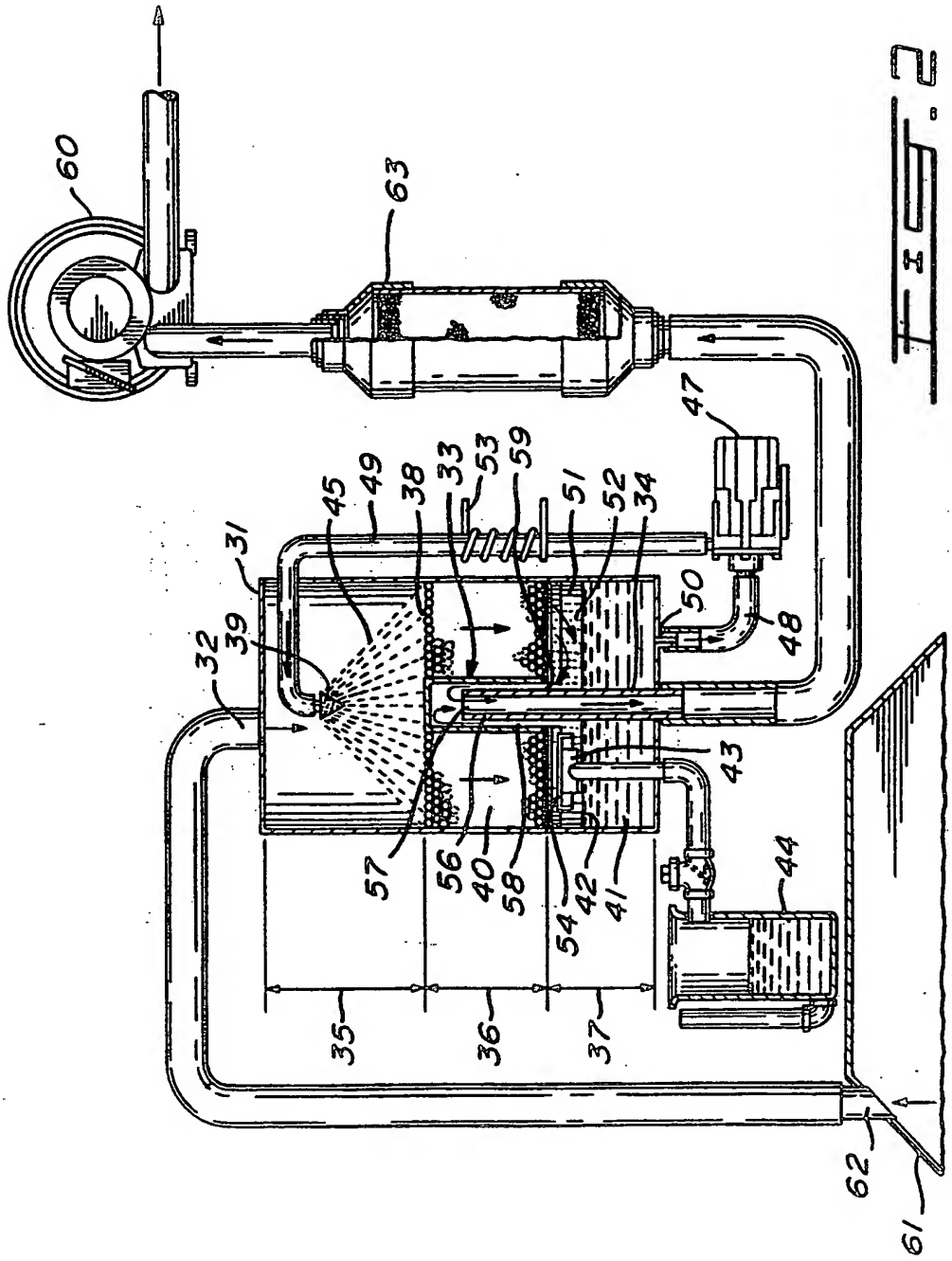

60
63
47
49
38
33
53
59
51
52
34
45
31
50
48
39
32
43
57
56
40
58
54
42
41
44
35
36
37
62
61

FIG. 2

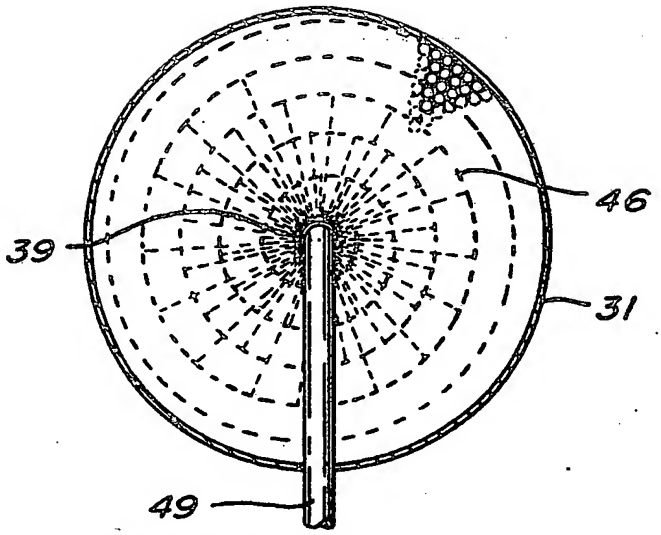



FIG. 3

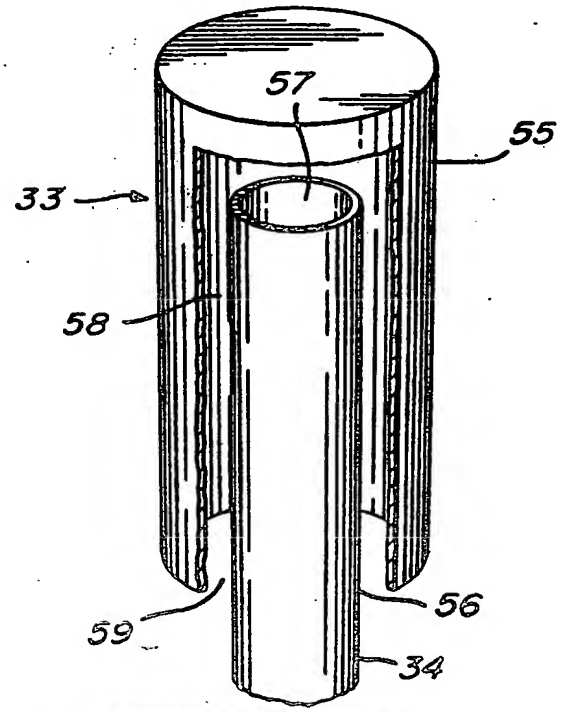



FIG. 4

International Application No

## I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 B01D50/0[redacted] B01D47/14; F24C15/20[redacted]

## II. FIELDS SEARCHED

Minimum Documentation Searched[7]

| Classification System | Classification Symbols |
|---|---|
| Int.Cl. 5 | B01D ; F24C |

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched[8]

## III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

| Category[10] | Citation of Document,[11] with indication, where appropriate, of the relevant passages[12] | Relevant to Claim No.[13] |
|---|---|---|
| A | US,A,4 900 341 (CSABAI)<br>13 February 1990<br>cited in the application<br>see the whole document | 1,3,4,<br>6-9,<br>15-20 |
| A | EP,A,0 065 584 (STEULER-INDUSTRIEWERKE)<br>1 December 1982<br>see page 4 - page 5; figure 1 | 1,2,7,<br>10,11 |
| A | EP,A,0 090 655 (JOHN THURLEY LIMITED)<br>5 October 1983<br>see page 3, line 27 - page 5, line 15;<br>figure 1 | 1,2,7,<br>10,11,13 |

[10] Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

## IV. CERTIFICATION

| Date of the Actual Completion of the International Search | Date of Mailing of this International Search Report |
|---|---|
| 27 JULY 1993 | 18.08.93 |
| **International Searching Authority** | **Signature of Authorized Officer** |
| EUROPEAN PATENT OFFICE | CUBAS ALCARAZ J.L. |

ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO

CA 9300089
SA 72146

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information. 27/07/93

| Patent document cited in search report | Publication date | Patent family member(s) | | Publication date |
|---|---|---|---|---|
| US-A-4900341 | 13-02-90 | CA-A- | 1292941 | 10-12-91 |
| | | EP-A- | 0298000 | 04-01-89 |
| | | JP-A- | 1034421 | 03-02-89 |
| EP-A-0065584 | 01-12-82 | None | | |
| EP-A-0090655 | 05-10-83 | None | | |

EPO FORM P079

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82